US008456272B2

(12) **United States Patent**
Rauh et al.

(10) **Patent No.: US 8,456,272 B2**
(45) **Date of Patent: Jun. 4, 2013**

(54) **ELECTRIC LINE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 31 days.

(21) Appl. No.: **13/181,600**

(22) Filed: **Jul. 13, 2011**

(65) **Prior Publication Data**

US 2012/0013433 A1 Jan. 19, 2012

(30) **Foreign Application Priority Data**

Jul. 15, 2010 (DE) 10 2010 027 408
Jun. 22, 2011 (DE) 10 2011 105 675

(51) **Int. Cl.**
H01C 13/00 (2006.01)

(52) **U.S. Cl.**
USPC **338/296**; 338/214; 219/549; 219/528

(58) **Field of Classification Search**
USPC 338/296, 214; 219/549, 528; 174/128.1, 174/36
See application file for complete search history.

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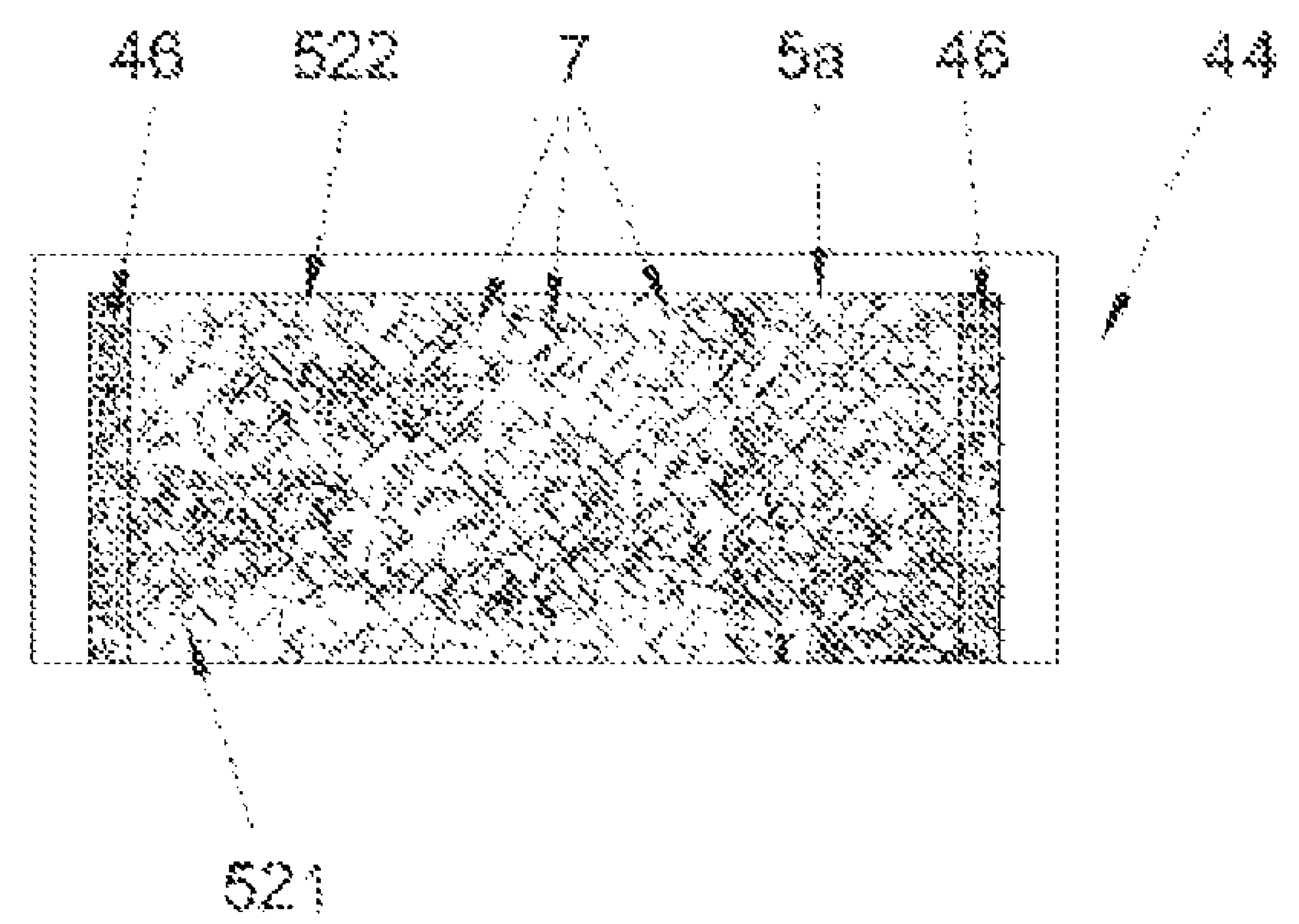
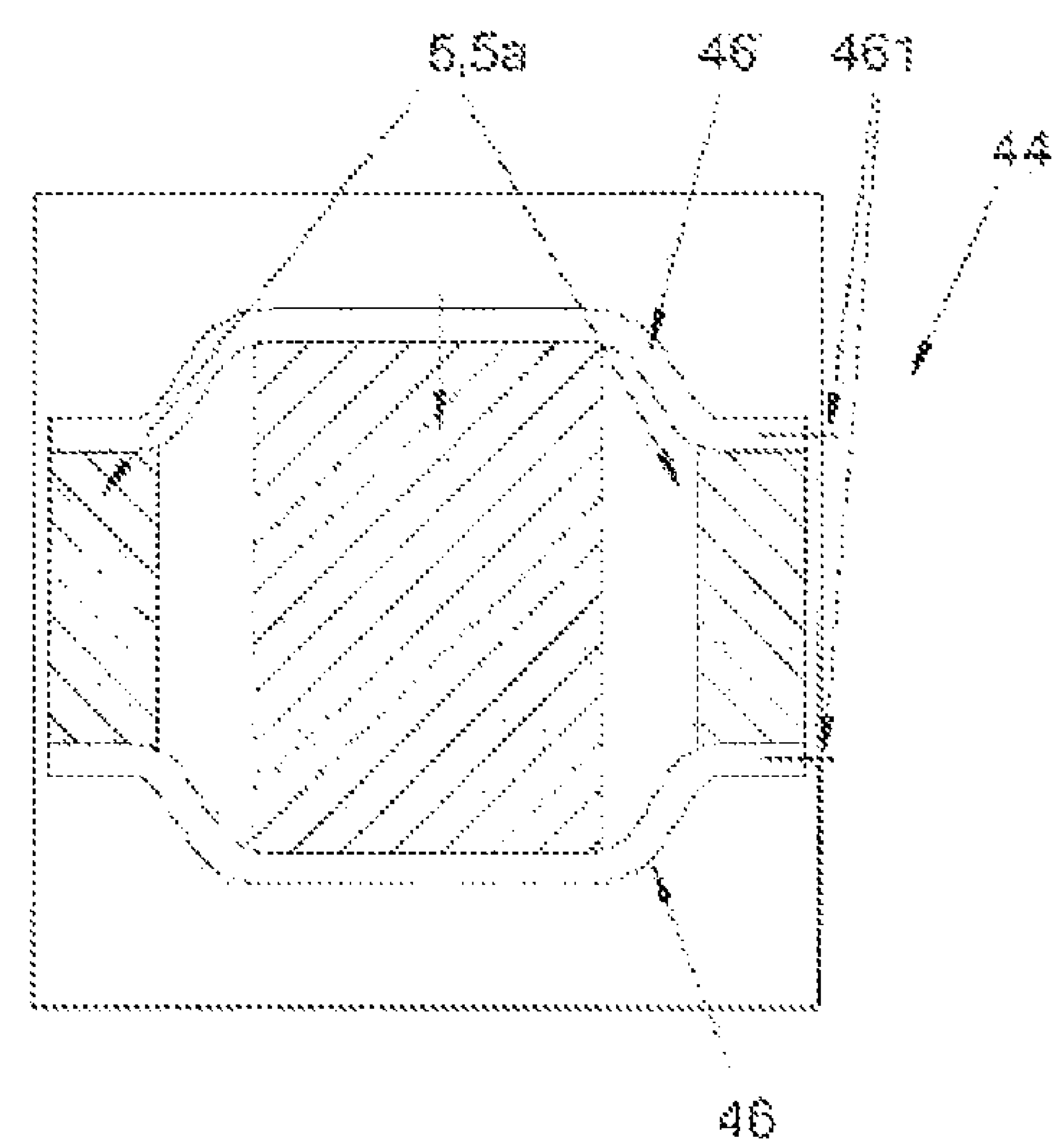
(57) **ABSTRACT**

An electric line comprising: at least one conducting substrate including at least two heating fields of different width, at least one shared contacting device, wherein the conducting substrate includes a coating material disclosed on the conducting substrate that forms the at least two heating fields, and the same coating material is disposed on the at least two heating fields, and wherein an electrical conductivity of the coating material on one of the at least two heating fields is different than a second one of the at least two heating fields of different width so that upon application of the coating material on the at least two heating fields, each of the at least two heating fields have an identical electrical resistance, and wherein the at least one shared contacting device connects the at least two heating fields to an electrical potential by one or more connection lines.

20 Claims, 8 Drawing Sheets





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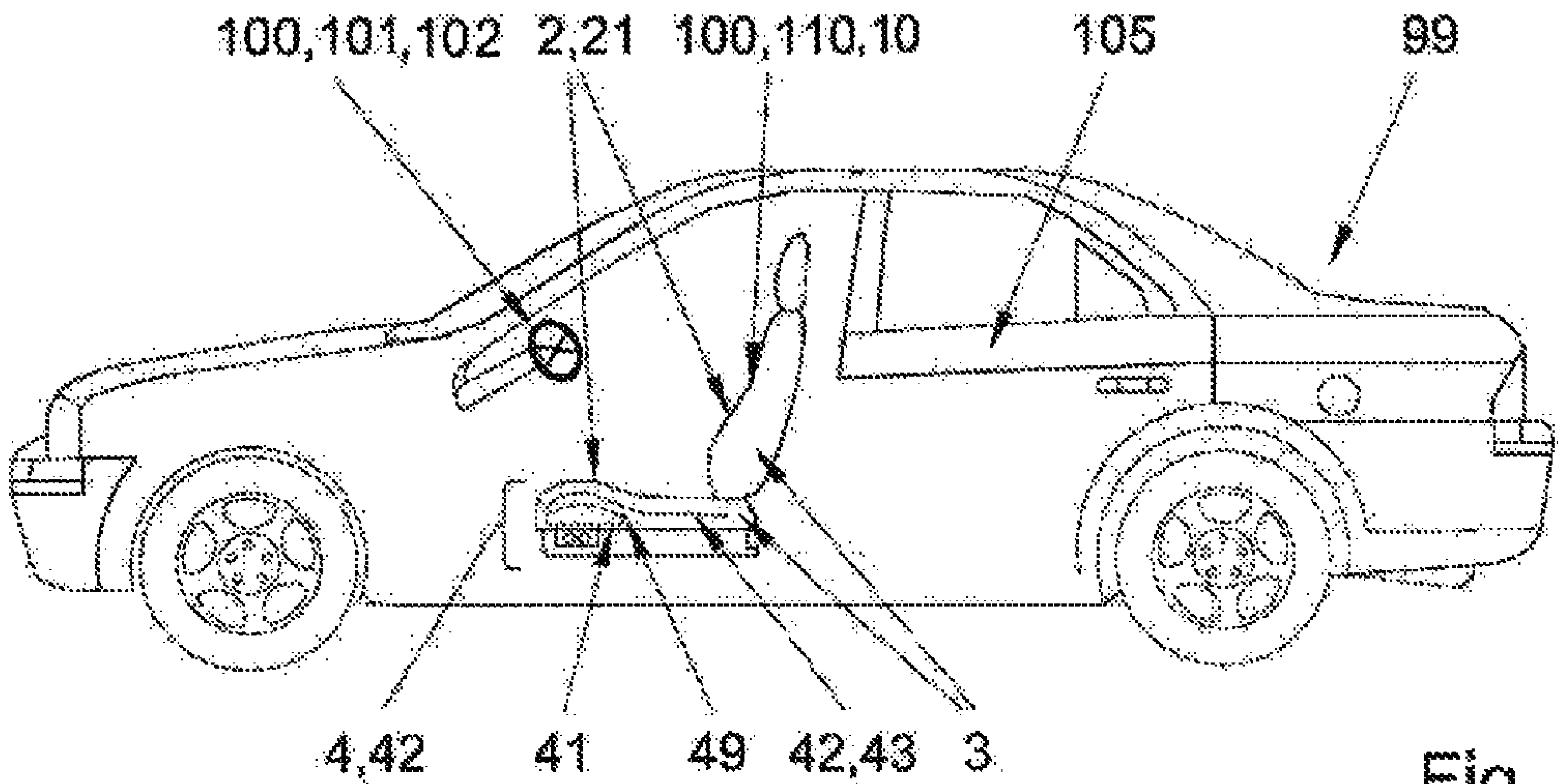

Fig. 1

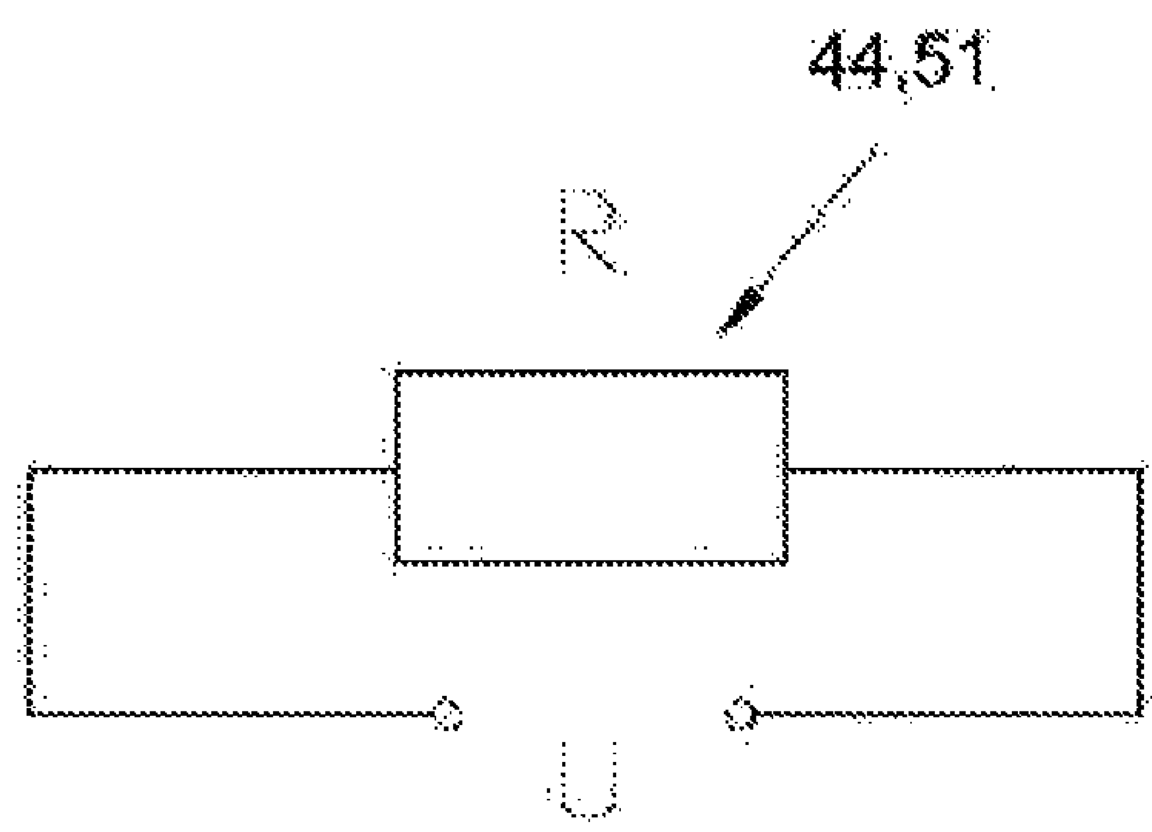

Fig. 2a

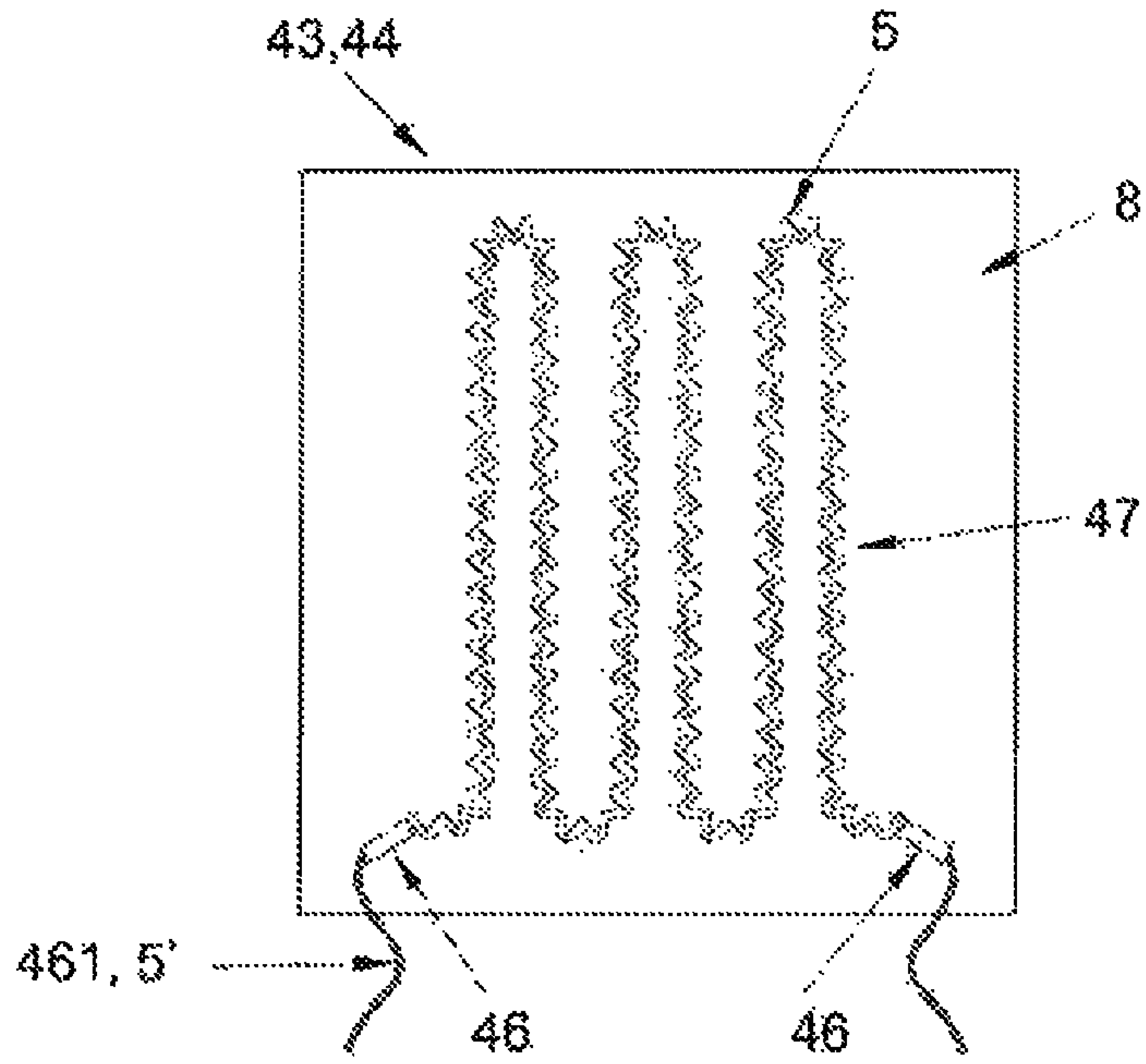

Fig. 2b

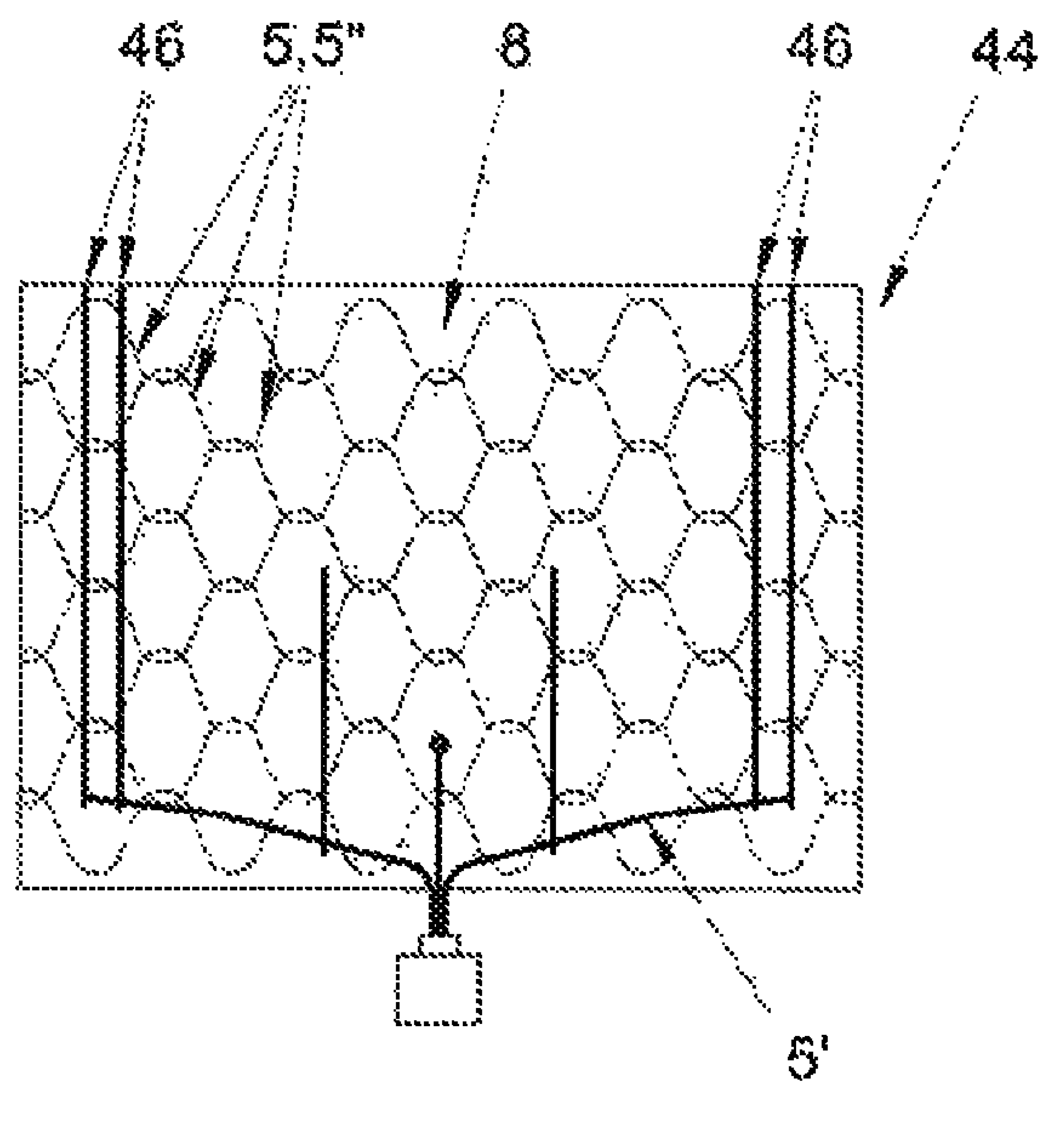

Fig. 2c

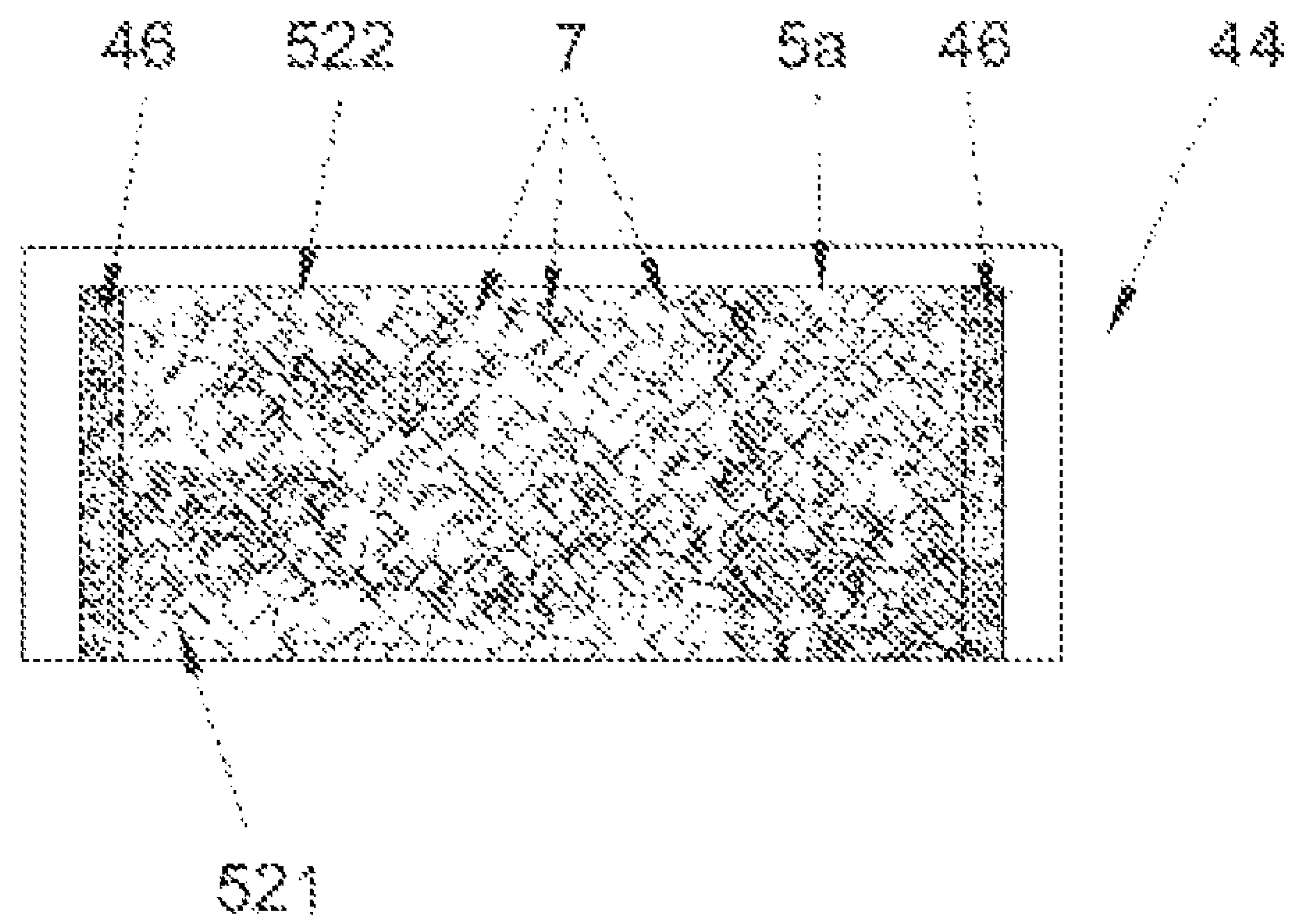

Fig. 2d

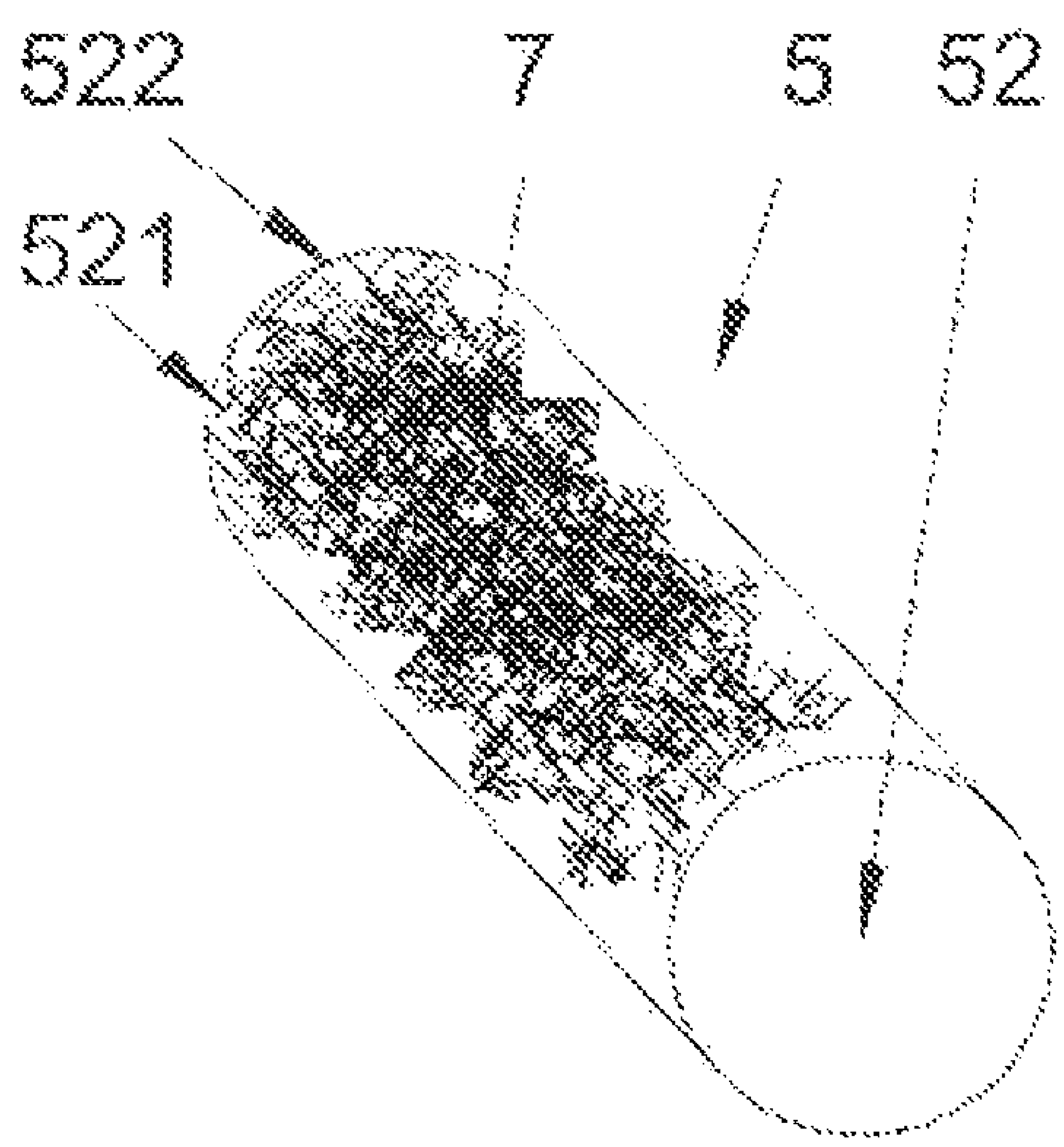

Fig. 3 a1

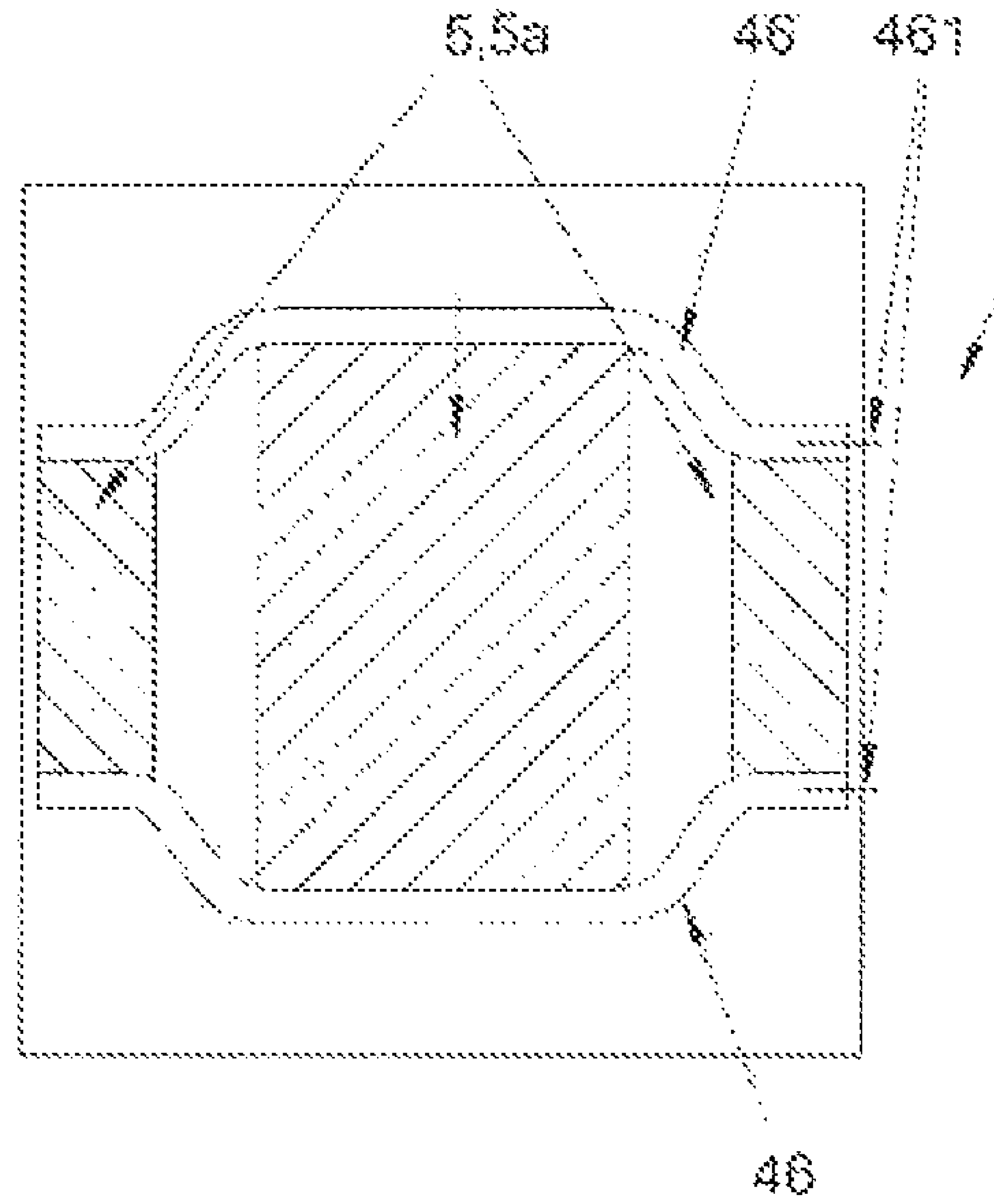

Fig. 2e

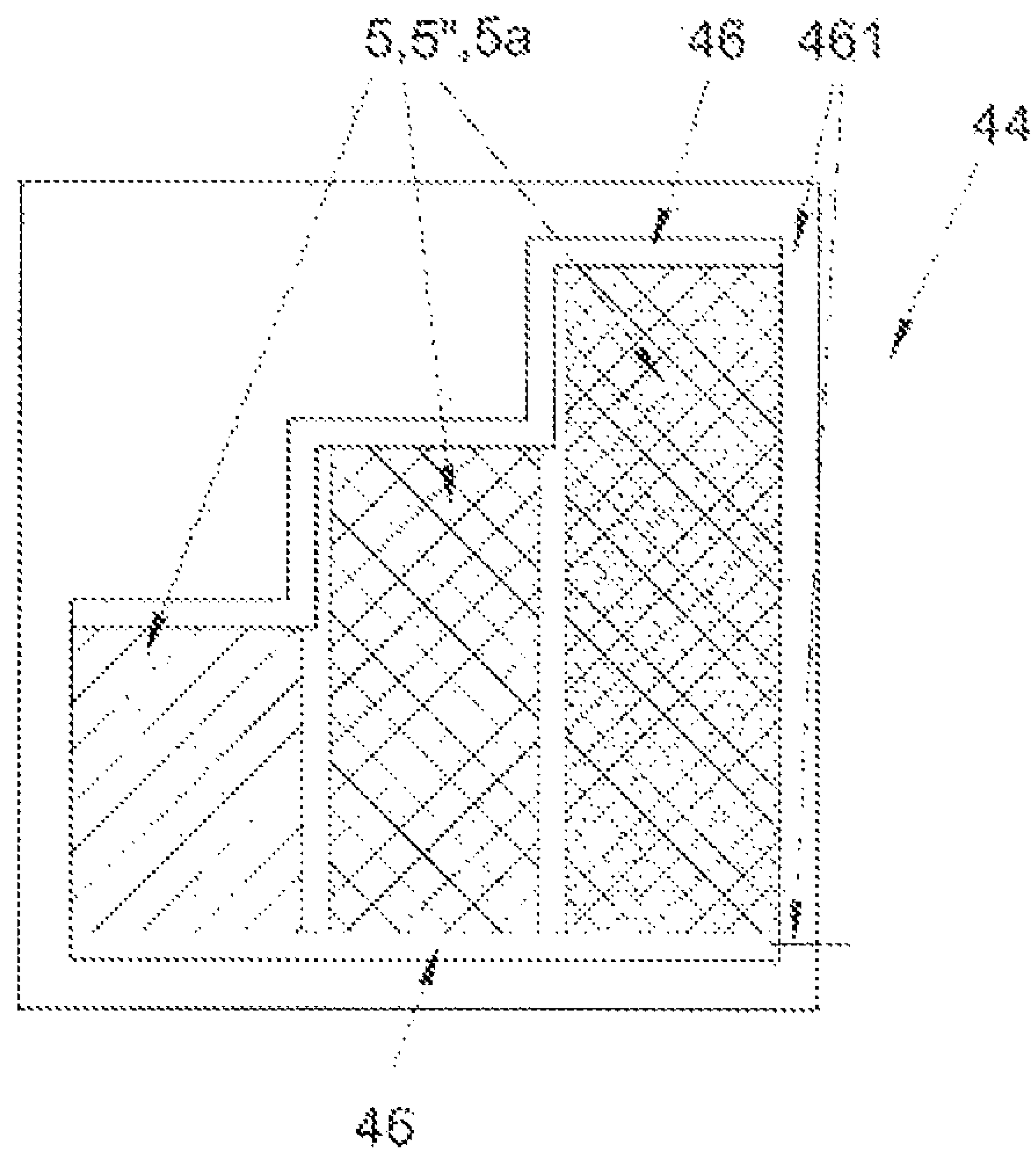

Fig. 2f

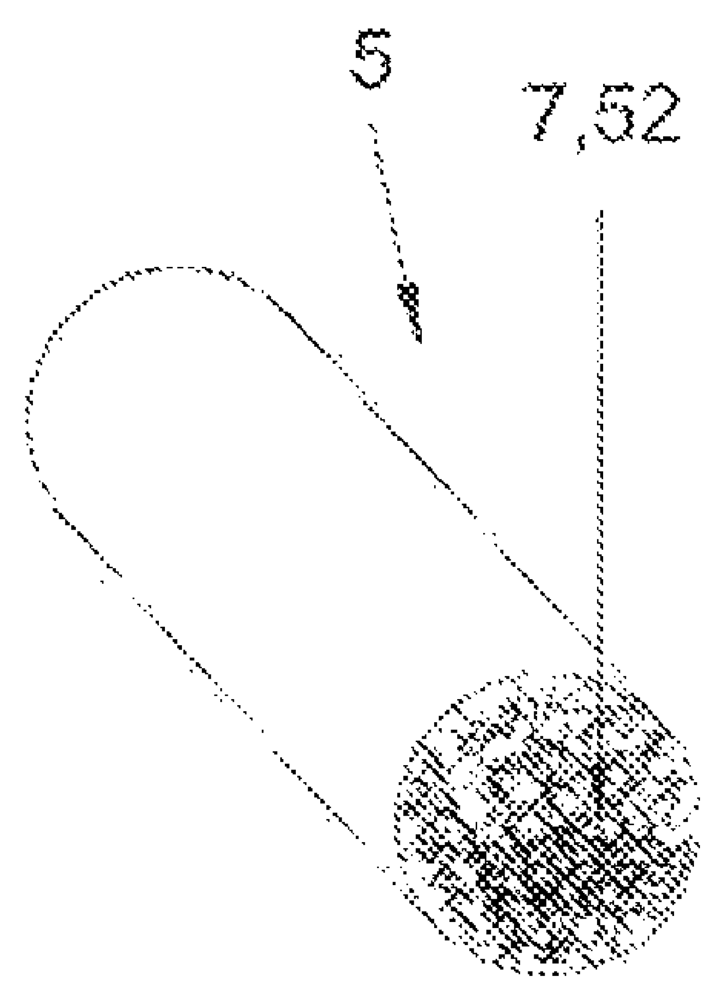

Fig. 3 a2

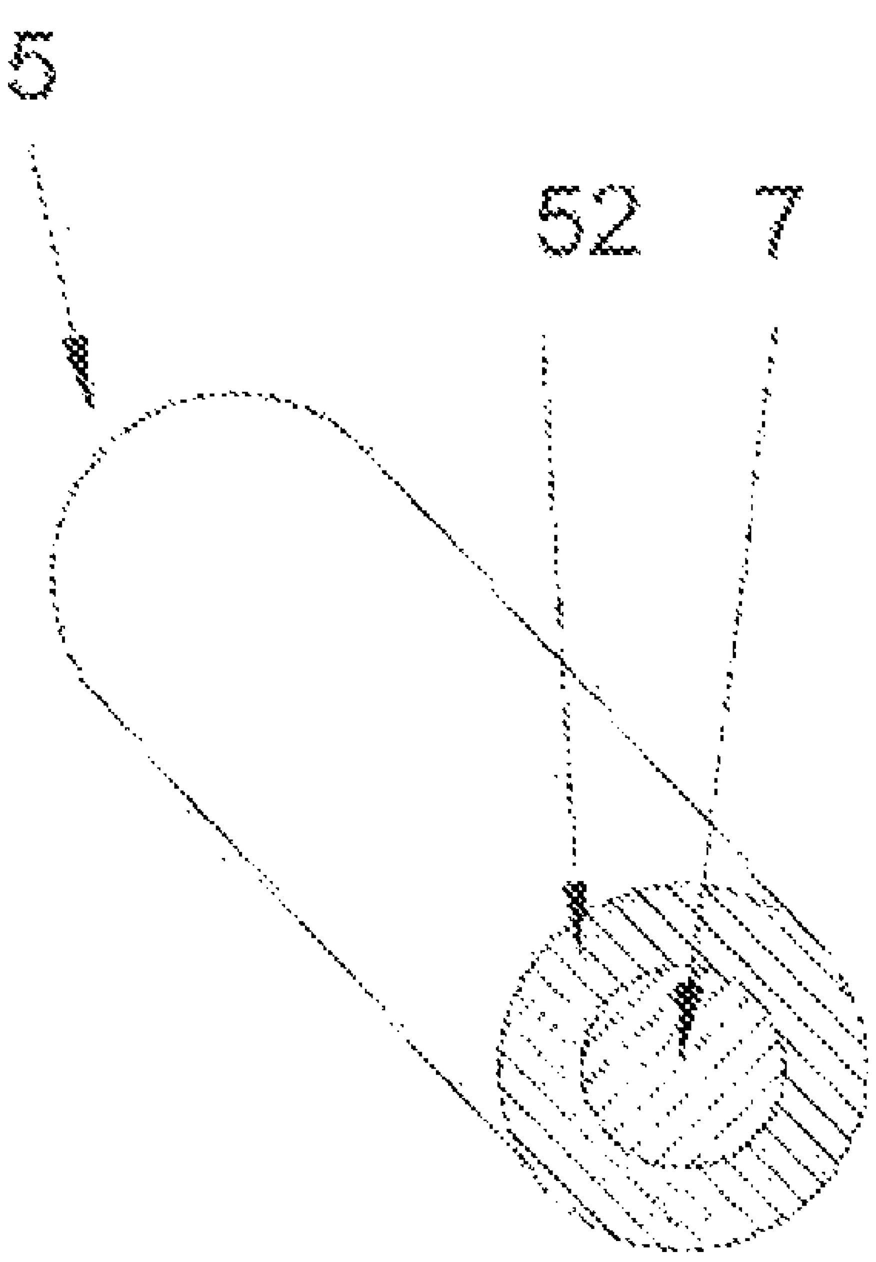

Fig. 3 a3

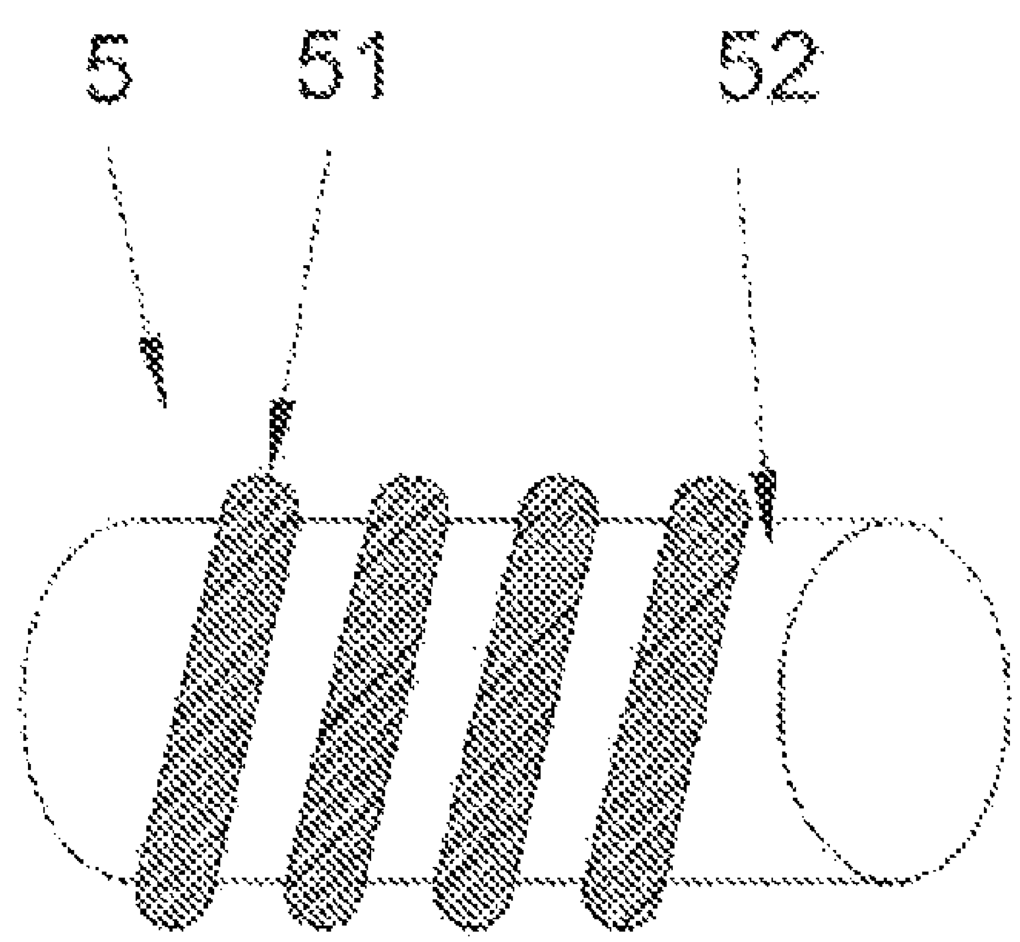

Fig. 3 b1

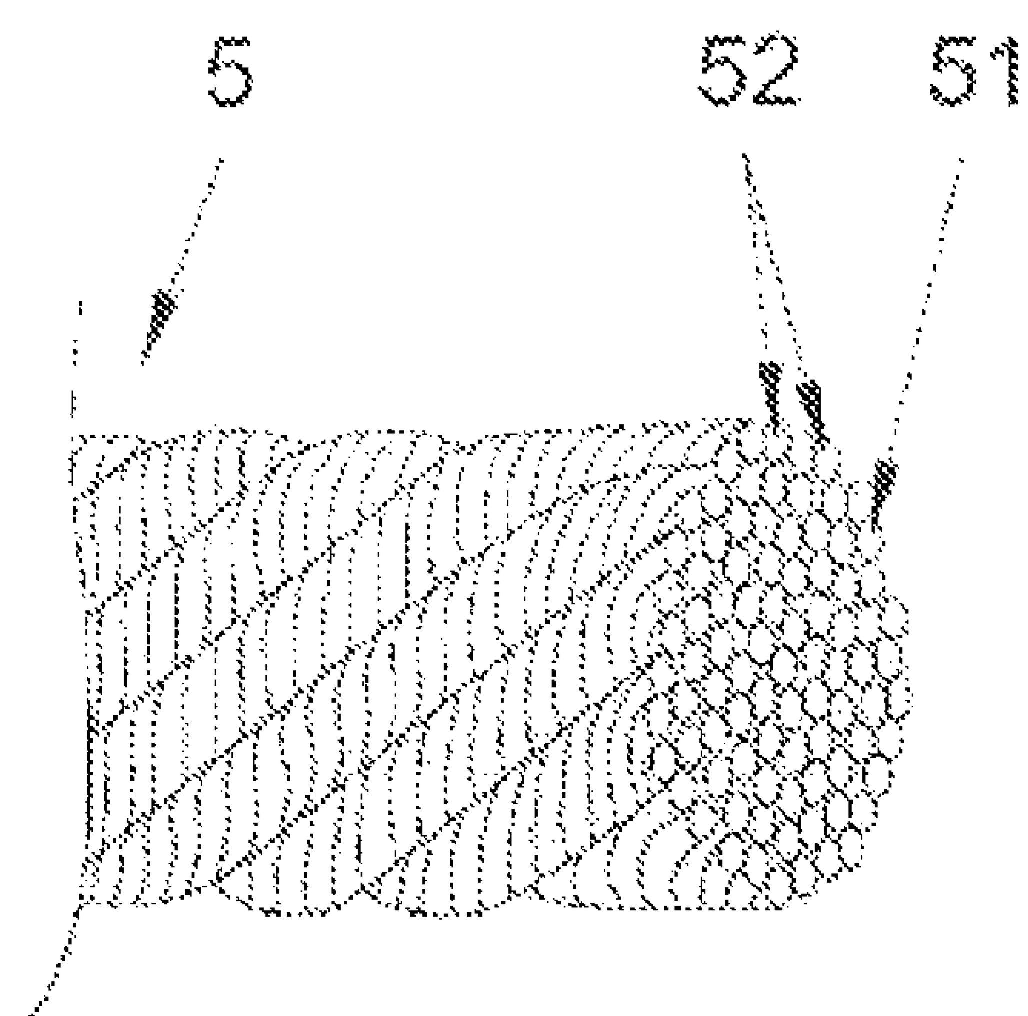

Fig. 3 b2

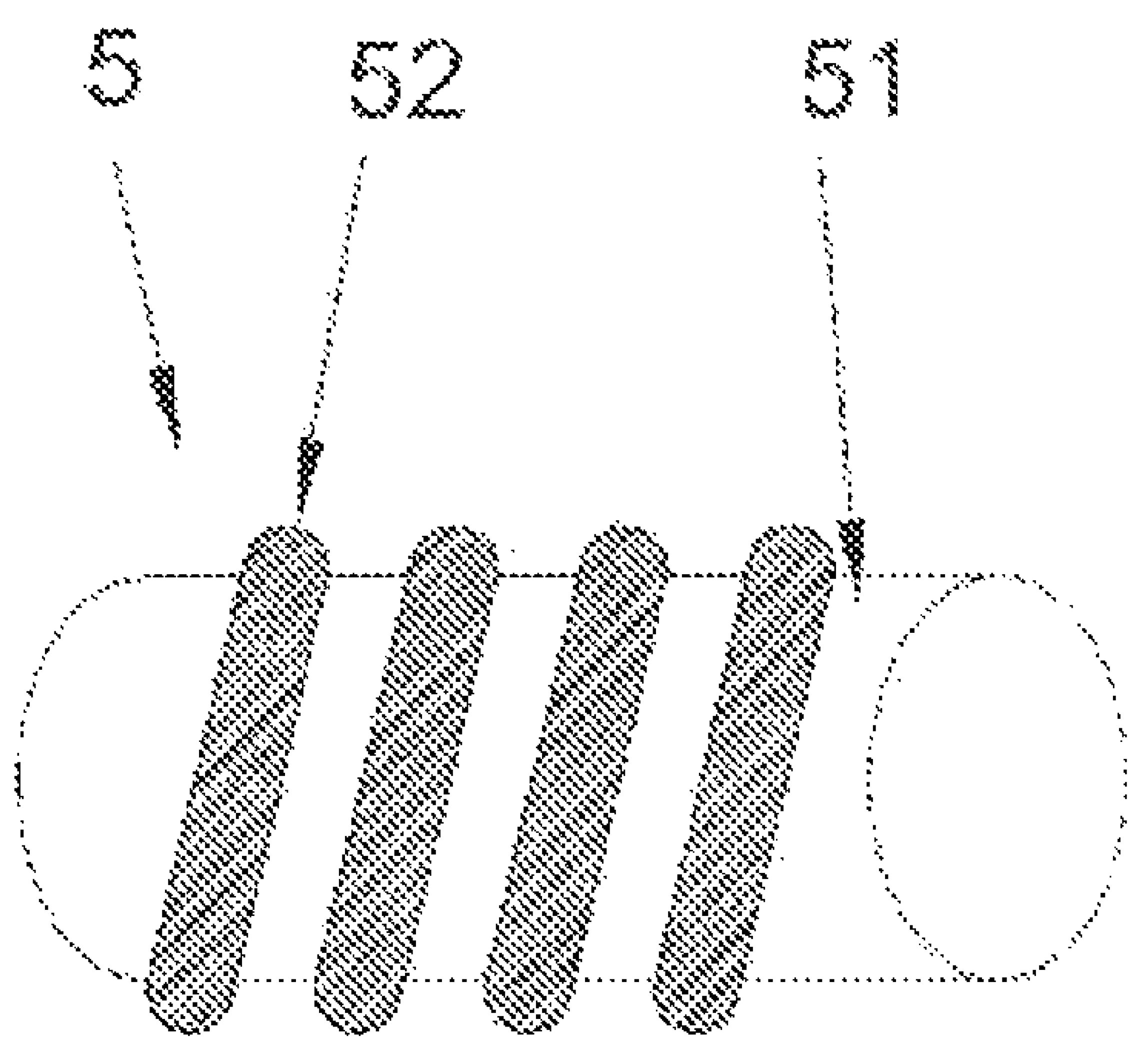

Fig. 3 b3

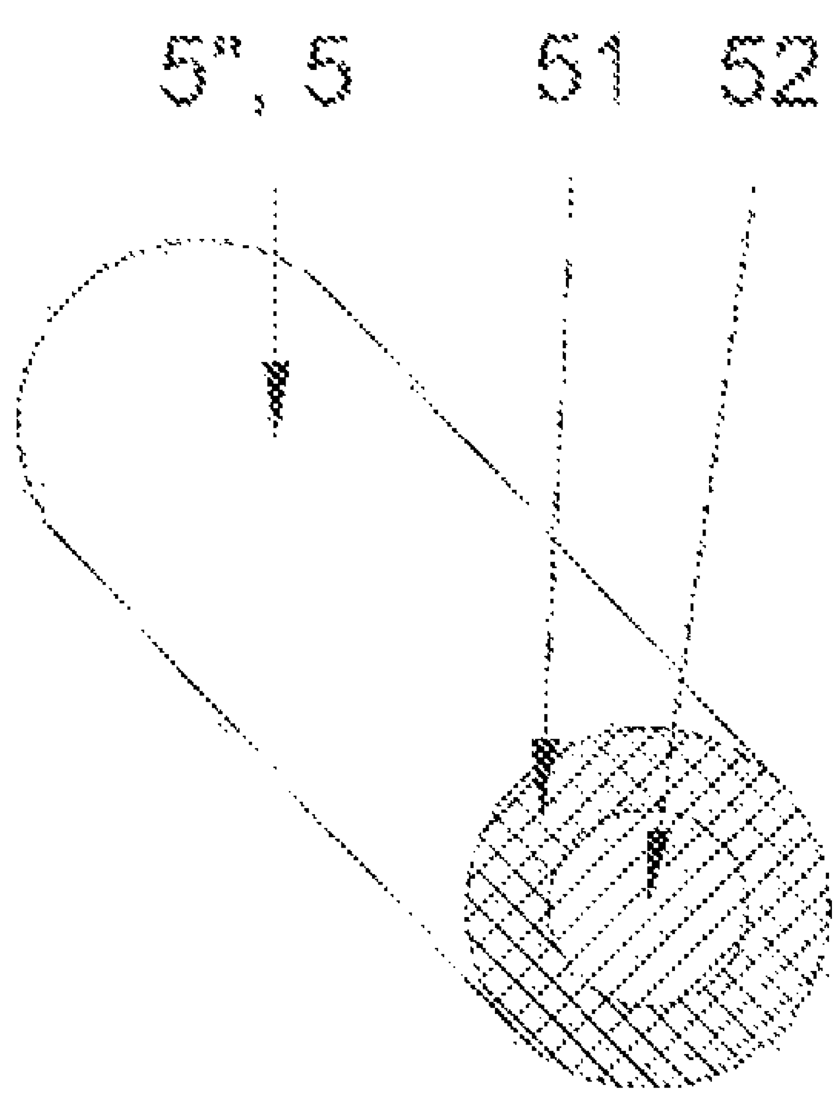

Fig. 3 c1

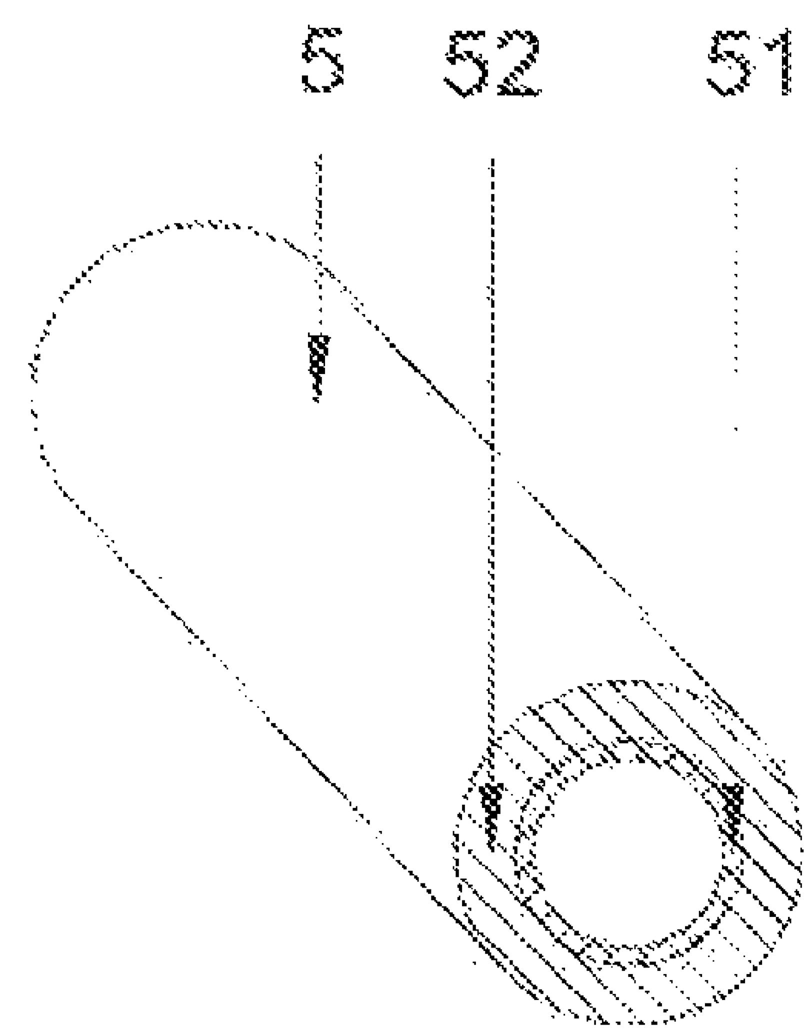

Fig. 3 c2

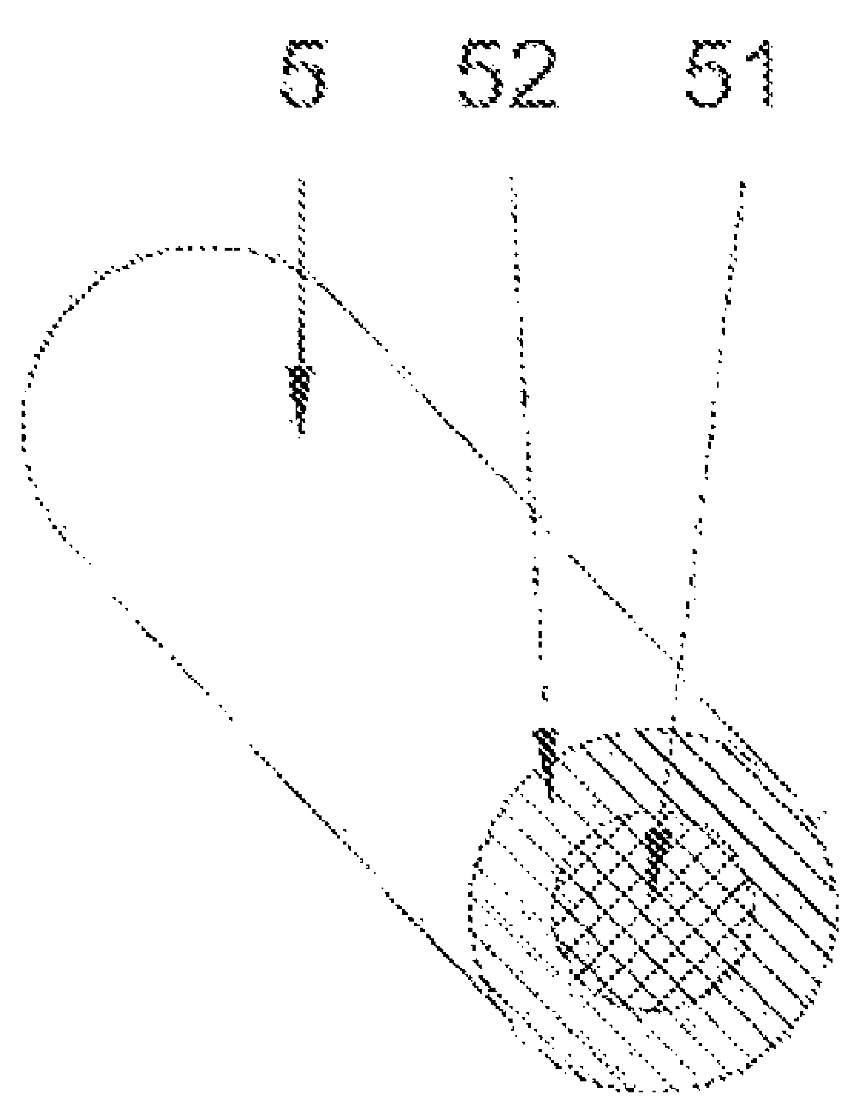

Fig. 3 c3

ELECTRIC LINE

CLAIM OF PRIORITY

The present application claims priority from German application nos. DE 10 2010 027 408.9, filed on Jul. 15, 2010 and DE 10 2011 105 675.4, filed on Jun. 22, 2011 to named applicant: W.E.T. Automotive Systems AG, inventors Hans-Georg Rauh, Dr. Martin Krobok and Michael Weiβ, disclosure of which is hereby incorporated by reference herein.

SUBJECT OF THE INVENTION

The invention concerns an electric line with at least one conducting substrate and at least one substrate support, on and/or in which the conducting substrate is arranged. Such lines are used, e.g., in electric resistance devices or in contacting devices, temperature control devices, air conditioning devices, detector devices, covers for temperature-controlled objects, vehicle interior components and/or it furnishing objects.

It is provided that the conducting substrate has at least one conducting particle.

Furthermore, it is provided that the conducting substrate has at least two strandlike conducting particles, which are in electrical connection with each other at least at one electrical contact point.

It is provided that the resistance device has at least two resistance zones which have an electrical conductivity different from each other.

FIGURES

Details of the invention will be explained below. These embodiments should make the invention comprehensible. However, they have the nature of examples. Of course, in the context of the invention, individual or several specified features can be left out, modified, or supplemented. The features of different embodiments can of course be combined with each other. What is decisive is that the concept of the invention is basically implemented. When a feature is at least partly fulfilled, this includes this feature also being completely fulfilled or basically completely fulfilled. "Basically" means in particular that the implementation enables an achievement of the desired benefit to a recognizable extent. This can mean, in particular, that a corresponding feature is at least 50%, 90%, 95% or 99% fulfilled. If a minimum quantity is indicated, then of course more than this minimum quantity can also be used. Unless otherwise indicated, intervals include their boundary points.

In what follows, reference is made to:

FIG. **1** side view of a motor vehicle **99** with temperature controlled objects **100** with temperature-controlled surfaces **10** such as a steering device **101**, a steering wheel **102**, a door paneling **105**, a seat **110**, in partial longitudinal section

FIG. **2***a*) basic principle of the circuit of such a heating device **44** with a strandlike conducting substrate **51**

FIG. **2***b*) first example of a heating device **44** and a temperature control device **43** with a strandlike lines **5**, **5'**, **461** as a heating conductor with two contacting devices **46** and a circuit brakes **47**, which are arranged on a sheetlike supporting device **8**.

FIG. **2***c*) second example of a heating device **44**, in which a plurality of strandlike lines **5**, **5''** are laid on a supporting device **8** between two contacting devices **46**.

FIG. **2***d*) third example of a heating device **44**, in which a plurality of conductive particles **7**, adhesive compound **522**, and fibers **521** form a conducting field **5***a*, which is arranged between two contacting devices **46**.

FIG. **2***e*) illustrates an example of a heating device **44** having different conducting fields **5***a* with standlike lines **5** arranged between two shared contacting devices **46** with connection lines **461**

FIG. **2***f*) illustrates another example of a heating device **44** having different conducting fields **5***a* with standlike lines **5**, **5''** arranged between two shared contacting devices **46** with connection lines **461** in a different configuration.

FIG. **3***a***1**) first example of an enlarged perspective view of an electric line **5**, for example, from FIG. **2***b*), with a strandlike substrate support **52** with one or more fibers **521**, an adhesive compound **522**, and conductive particles **7** arranged on its surface.

FIG. **3***a***2**) second example of a line **5** with a strandlike substrate support **52**, in whose mass a plurality of electrically conductive particles **7** is embedded.

FIG. **3***a***3**) third example of a strandlike line **5** with a tubular substrate support **52**, whose hollow core is filled with a plurality of conducting particles **7**.

FIG. **3***b***1**) fourth example of a line **5** with a strandlike substrate support **52**, about which a strandlike conducting substrate **51** is wound in spiral/helical form.

FIG. **3***b***2**) fifth example of a line **5**, in which strandlike conducting substrates **51** are stranded with strandlike support parts **52**.

FIG. **3***b***3**) sixth example of a line **5** with a strandlike conducting substrate **51** and a substrate support **52** wound about it in helical form.

FIG. **3***c***1**) seventh embodiment of lines **5**, **5''** with a strandlike substrate support **52** and a coating deposited on it in tubular manner as a conducting substrate **51**.

FIG. **3***c***2**) eighth example of a line **5** with a tubular substrate support **52**, in which a tubular conducting substrate **51** is inserted. A cavity can remain here in the core or a filling can be provided with a conductive or nonconductive material.

FIG. **3***c***3**) ninth example of a line **5** with a tubular substrate support **52** and a strandlike conducting substrate **51** arranged therein.

DESCRIPTION OF THE INVENTION

The invention pertains to the temperature control of at least one temperature-controlled object **100**. This includes, in particular, all objects or surfaces touched by people or endangered by frost, such as airfoils, transmitting stations, refrigerators, interior furnishing objects of houses, doors, windows, ceilings, recliners, cushions, etc. It can also involve, as here, an interior furnishing object of an air, water, land, railway or motor vehicle **99**, such as that per FIG. **1**, as for example a steering device **101**, a steering wheel **102**, a dashboard **103**, an arm rest, a door paneling **105**, a sitting surface, a vehicle ceiling, a cushion, an upholstery cover or, as here, a seat **110**.

At least one object **100** being temperature-controlled has one or more temperature-controlled surfaces **10**. Preferably, at least one temperature-controlled surface **10**, like the sample embodiment of FIG. **1**, preferably has at least one cover **2**. Cover means any kind of layer, upholstery back cloth, or laminate, which at least partly covers the temperature-controlled object **100**; especially such a one that is arranged as a continuous sheetlike component on the temperature-controlled object **100** and/or can basically be continuously detached from it. In addition or alternatively, a temperature-controlled surface **10** can also be provided with one or more coatings. By coatings is meant in particular such layers as are arranged at least temporarily as small particles (e.g., granulate or powder) or liquid (such as dipping lacquer, spray lacquer, or melted particles) on the temperature-controlled object **100** and, after solidification, form a continuous formation of predominantly two-dimensional extent. In addition or alternatively, a temperature-controlled surface **10** can have an at least partly continuous component **21** with basically sheetlike parts, such as textile, leather, nonwoven fabric and/or spacer materials, such as spacer fabrics. Several sheetlike components of the temperature-controlled surface **10** can be sewn, glued, riveted, Velcro fastened, welded together, or so on.

At least one temperature-controlled object **100** has preferably one or more cushions **3**. These are preferably configured as foam rubber bodies and are part of a seat **110**, a steering wheel **102**, and so on.

One or more air conditioning devices **4** are coordinated with at least one temperature-controlled object **100** and at least one temperature-controlled surface **10** in order to control their temperature or air condition them.

At least one air conditioning device **4** advisedly has one or more air conducting devices **41**. By air conducting device **41** is meant any device that can be used for the air exchange for the specific changing of the air composition or the air flows in a particular surface or volume region, such as an onboard climate control system, spacer media, spacer fabrics and/or air conditioning inserts at least partly permeable to air.

At least one air conditioning device **4** advisedly has one or more humidity regulating devices **42**. By humidity regulating device is meant a device that serves to regulate the humidity of the air in its surroundings, especially the mentioned air conducting devices, temperature control devices **43** or humidity absorbers, such as activated charcoal fibers or polymer superabsorbers.

At least one air conditioning device **4** advisedly has one or more temperature control devices **43**. By temperature control device **43** is meant any device that can be used for the specific changing of the temperature in its surroundings, e.g., all devices with at least one electrical heating resistor per FIGS. **2** and **3**, a heat pump, a Peltier element and/or an air moving device, such as a fan.

At least one temperature control device **43** preferably has at least one electrical heating device **44**. Such a heating device is preferably designed as a textile surface heating element. It can be used, e.g., as an insert in the cushioning of a furnishing object, such as a seat **110**.

At least one heating device **44** preferably has one or more electrical resistance devices **45**, to convert electrical energy into thermal. Preferably, one or more electrical resistance devices **45** are configured so that they lose at least partly their electrical conductivity at temperatures over 100° C., depending on the application also over 200° C. or over 250° C. Depending on the application, this can be below 150° C., below 200° C. or also below 260° C. At least one resistance device **45** and/or one of its components preferably has a PTC effect.

At least one resistance device **45** preferably has one or more lines **5** for the temperature control.

A heating device **44** preferably has one or more contacting devices **46**, in order to apply an electrical potential at least on one resistance device **45**.

Preferably the heating device **44** has two or more contacting devices **46**, which are arranged on a resistance device **45** at least partly spaced from each other. Preferably, they are arranged near the edge along the resistance device **45** and fastened to it, e.g., by sewing, gluing, or imprinting. They can have an elongated contour and run essentially in a meandering fashion (e.g., FIGS. **2***e*), *f*)) and/or in a straight line (FIGS. **2***c*), *d*)). They are preferably arranged roughly parallel to each other and connected at one of their ends to a current/voltage source by a one or more connection lines **461** (e.g., FIGS. **2** *e*) *f*)). If more than two contacting devices **46** are arranged on a resistance device **45**, certain of their regions can have current applied to them independently of the others.

Contacting devices **46** can basically be made from the same materials as a resistance device **45**. For this, a rather large quantity of a conductive material is preferably provided. This can be done, e.g., by imprinting a resistance device on a sheetlike support device, e.g., with silk screening. After this, one or more additional layers are imprinted in the edge region, in order to form electrodes.

A contacting device **46** preferably has one or more lines **5'** for making contact, being in electrically conductive connection with a resistance device **45**. Advisable, in particular, is a number of two to ten, preferably three to eight contact conductors.

A heating device **44** advisedly has one or more temperature sensors. These monitor the temperature level of the heating element and/or the surroundings in order to assure maximum comfort and safety. Such a temperature sensor can be, e.g., a thermostat.

At least one heating device **44** advisedly has one or more circuit breakers **47**, to interrupt the current supply to at least one resistance device **45** and/or one conductor device. In this way, needless energy consumption and unpleasant temperatures can be avoided. Such a circuit breaker **47** can be formed by at least one line **5"**, which loses its electrical conductivity at least partly and/or at least temporarily in event of passing a temperature threshold value, e.g., by melting or burn-through.

An air conditioning device **4** preferably has one or more detector devices **49**, e.g., in the form of humidity sensors, in order to determine the moisture in a seat and/or the surrounding air or other parameters.

The air conditioning device **4** or one or more of its components (e.g., resistance device **44**, contacting device **46**, etc.) has one or more lines **5**, **5'**, **5"**. These can be designed, e.g., as contacting devices **46** or connection lines **461** to the current line, as resistance devices **45** to produce heat, and/or detector devices **49** to monitor the temperature.

Preferably, the electrical conductivity of at least one line **5**, **5'**, **5"** at undesired high temperature (e.g., 200° C. to 400° C., better between 220° C. and 280° C.) is temporarily or permanently at least locally reduced or eliminated entirely. This prevents an unacceptably high heating. It can be provided that the line **5** is interrupted partly or basically entirely, reversibly or irreversibly, in the mentioned temperature range.

Preferably, the electrical resistance of at least one line **5**, **5'**, **5"** fluctuates preferably at least in one particular temperature range by at most 50% of its resistance at room temperature (around 20° C.), or better by at most 30% or 10% The temperature range preferably covers the interval of −10° C. to +60° C., or better −20° C. to +150° C., or better −30° C. to +200° C. This can be accomplished, e.g., by pre-stretching, warm-storing, water baths, or the like. This holds especially for plastic-containing lines **5**. Preferably, the electrical resistance lies between 0 and 3 Ω/m, better 0 and 2 Ω/m, better 0.1 and 0.3 Ω/m for the current transport or between 0.1 and 5 Ω/m, better 0.8 and 3 Ω/m, for the heating.

Preferably at least one line **5**, **5'**, **5"** has at least one conducting substrate **51** for the conducting of electric current and/or at least one substrate support **52** to support the conducting substrate **51**.

Preferably at least one substrate support **52** is partly or basically entirely made from a material having a greater resistance to alternating bending and/or a distinctly higher material price and/or a lower tensile or compressive strength than the material of the conducting substrate **51**. In addition or alternatively, a substrate support **52** can also contain one or more fibers **521** of a high-strength material, such as Aramid, carbon, Zylon, etc. By high-strength is meant in particular a material with a tensile strength of more than 2500 N/mm^2 or 2500 MPa. Preferably, one or more mineral fibers are used, e.g., glass. This provides a high temperature resistance and is especially suitable for use in a load-bearing inner strand of a line.

In addition alternatively, preferably one or more substrate supports **52** have one or more fibers **521** that are formed partly or entirely from plastic, e.g., from carbon, nickel-clad carbon fibers, Nylon, polyethylene, PVC, polyimide, polyamide (e.g., 1.2, 3.4, 53, 6.6, 6.10, 7.2, 8.1), polypropylene, polyester, polyurethane etc. These materials are easy to process and economical in price. They are especially suitable for an inner strand **52***a*, but also, e.g., as an adhesive compound in a conducting substrate **51**. A plastic is any synthetic material not occurring in nature, especially polymers and substances derived from them, like carbon fibers. Preferably, the chosen material is elastic and resistant to tearing.

For lines **5**, **5'**, **5"** without a PTC characteristic, at least one substrate support **51** is preferably designed so that it loses its material coherence upon passing a certain temperature value. For this, it may be advisable for the substrate support **52** to be made from a material that chemically decomposes or evaporates once certain temperature values are passed, so that it at least partially dissolves and is broken up. In this way, the supporting basis is taken way from the conducting substrate **51** once an unacceptable heating occurs. For this, it can be expedient that the substrate support **52** shrink, contract, and/or tear and thereupon disrupts/rips a layer above it that forms the conducting substrate **51**, so that the conductivity of the conducting substrate **51** is ruined. It can be expedient for this that the substrate support **52** be made at least partly from a material with "memory" effect. It can be expedient for the substrate support **52** to at least partially melt, soften or decompose at temperatures between 100° C. and 400° C., preferably between 150° C. and 300° C., preferably between 220° C. and 280° C., here, at 270° C. At least one substrate support **52** preferably has a material that remains chemically and/or mechanically at least as stable up to at least 150° C., preferably up to at least 200° C., preferably up to at least 250° C. as under standard conditions. In this way, the material is sufficiently heat-resistant for the ordinary heating duty. Heat resistant means that the particular material insignificantly changes its shape and its strength under routine temperature changes, remains chemically stable, and keeps the same state of aggregation as under standard ambient conditions.

The electrical resistance of a line **5** with conductively coated materials depends not only on the quality of a conductive coating serving as a conducting substrate **51**, but also on the quality of the substrate support **52**. In particular, the long-term stability of the electrical resistance is strongly influenced by this, because a disruption of the substrate support **52** can also damage the conducting substrate **51** supported by it.

It has been found that the long-term resistance of a substrate support **52** to aging, material fatigue and thermal stress, especially in the case of polymer materials, is especially high when at least parts of the material of the substrate support **52** have a high molecular weight and/or a high crystallinity. This holds at least as long as these stresses remain below the melting point, the softening temperature, and/or the decomposition temperature of the material. A certain energy per gram is needed to melt crystals. The more or greater the crystals are per unit of mass of the plastic, the more energy will be needed. Therefore, the melting energy per mass (J/g) is a measure of the crystallinity of a partly crystalline plastic.

Extensive tests have shown that the stability is especially good when at least 50% of the material of the substrate support **52** is in crystalline form, while the other fractions are present in amorphous structure. Preferably, the crystallinity of a plastic is at least 50 J/g, preferably at least 60 J/g, even better 70 J/g. This increases the adhesion of a coating to the substrate support **52**. This holds in particular for the aforementioned plastics. Furthermore, it was established that making the substrate support **52** from a material with high molecular weight counteracts the penetration of water into the support material. Preferably the molecular weight of one, several, or basically all of the substrate supports **52** is therefore at least 40,000 g/mol, better 100,000 g/mol, better 130,000 g/mol, better 200,000 g/mol or more. This holds in particular for the aforementioned plastics.

Preferably one or more substrate supports **52** have at least fractions of a material whose electrical conductivity behaves differently in regard to at least one parameter of influence than at least one material fraction of at least one conducting substrate **51**. Preferably, the electrical conductivity changes in dependence on the temperature.

Substrate supports **52** are usually made at least for the most part of an electrically nonconducting material. But it can also be specified that at least one substrate support **52** is made entirely or partially from an electrically conducting material and carries part of the current. This can be advisable, e.g., for lines **5**, **5'**, **5"** with PTC characteristic. In such a case, preferably the greater part of the current flows across the conducting substrate **51** and less than 50%, better less than 20%, better less than 10%, across the substrate support **52**. Advisable for this are, e.g., metals like copper, steel or nickel, electrically conductive plastics, graphite, or mixtures of alloys thereof.

It can be expedient for the substrate support **52** to have a thickness of less than 500 μm, preferably between 100 and 2 μm, preferably between 50 and 0.1 μm, preferably between 15 and 0.1 μm.

Preferably at least one substrate support has, at least for a section, an adhesive compound **522**, or it is formed wholly or partly from it, in order to support one or more conducting substrates **51** or parts thereof. At least one part of the adhesive compound **522** is preferably at least partly formed from an at least temporarily adhesive and/or nonmetallic material and/or a material with the potential to connect joining parts surface bonding (abhesion) and/or internal strength (cohesion). At least one part of the adhesive compound **522** is preferably applied at least partly by brush application on a sheetlike support device **8** remaining permanently or temporarily in the temperature control device **43**, sprayed on with pressure, deposited by dipping in a bath or by powder coating. This includes in particular melt, contact, powder and/or spray adhesives or corresponding bonding agents. Especially well suited are materials with at least fractions of rubber, PU, synthetic resin, adhesives and/or plastisols.

Preferably, at least one line **5**, **5'**, **5"** has one or more conducting substrates **51**. By this is meant such components of the line **5** that have at least for a section and/or temporarily a specific electric conductivity of at least 1 million Ω*cm, preferably at least 1 Ω*cm.

Preferably one or more conducting substrates **51** are partly or basically entirely arranged on or in a substrate support **52**. This can be done, e.g., by intimate material connection., e.g., in that one or more conducting substrates **51** are provided as sheetlike and/or tubular coating on or around a sheetlike or strandlike substrate support **52**. It is also possible, e.g., for a conducting substrate **51** to be fastened, e.g., as a strand, band, netting or layer, by form fitting or nonpositive fitting, e.g., by weaving, knitting, sewing on or in a sheetlike substrate support **52** or by winding in a spiral around a strandlike substrate support **52**. Preferably, one or more conducting substrates **51** are directly coordinated partly or basically entirely with a surface being temperature-controlled, e.g., by arrangement on a cover **2** and/or embedding at least partly in an object **100** being temperature-controlled, e.g., by foaming or casting in a cushion foam rubber.

Preferably one or more conducting substrates **51** are formed or a section or basically entirely as a layer **51**.1 and have at least for a section material thickness, especially a layer thickness, of 1 nm to 15 μm, better 1 nm to 1 μm, better 20 nm to 0.1 μm. Since usually only one thin layer can be applied in one process step, several layers can also be provided one on top of another. Preferably one or more conducting substrates **51** are applied for a section or basically entirely by lacquering, dipping, painting or by cathodic immersion painting or extrusion. Between one or more conducting substrates **51** and one or more substrate supports **52**, a chemically inert material is preferably deposited at least in a spot or section, such as a layer with 1-100% fractions of silver, palladium and/or gold. This can produce an improved bonding of subsequently applied materials on a substrate support **52** that forms the actual conducting substrate **51** or the larger portion of the conducting substrate **51**.

Preferably one or more conducting substrates **51** has, for a section or basically entirely, the shape of a strand, band, netting and/or a helix or spiral. It can be provided that a conducting substrate **51** is irregularly shaped and has, e.g., zones of different material thickness. In particular, the conducting substrate **51** can have constrictions, thickenings, and/or recesses. In this way, one can also create from a homogeneous material regions in the conducting substrate **51** whose electrical resistance is specifically adjusted.

Preferably one or more conducting substrates **51** are formed for a fraction or basically entirely from a material that has a PTC characteristic. Suitable for this are, e.g., graphite-containing plastics, especially materials filled with carbon black. Preferably a material is used whose electrical resistance rises especially in nonlinear fashion at temperatures above 120° C., preferably above 70° C. For example, the material applied can be "7282 PTC Carbon Resistor" from DuPont, which shows at around 80° C. a nonlinear, very abrupt rise of the resistance to twice to 20 times the value at room temperature. With this, one can very easily achieve a self-regulating heating element that cannot get overheated in any operating duty.

Preferably one or more conducting substrates **51** are made partly or basically entirely from a material whose conductivity is long-term stable, even in an environment with high humidity, preferably one having an electrical conductivity of at least 80%, better 90%, better 95% of its original value according to a humidity testing per DIN EN 600068-2-30. Especially suitable for this are materials having at least fractions of one or more of the following materials: metal, copper, copper alloy, nickel (especially with phosphorus fractions), carbon particles, carbon fibers, carbonized plastic filaments, silver, gold, zinc, Baytron, Baytron P, polyaniline (PANI), polythiophen, poly(3,4-ethylene dioxythiopen) (PEDOT), polystyrene sulfonate (PSS), polyacetylene (PA), polyphenylene (PP), polyphenylene vinylene (PPV), polythiophene (PT) and/or combinations and/or compounds containing the mentioned materials, molecules and/or derivatives.

Preferably one or more conducting substrates **51** have one or more fibers **521**. These can consist, e.g., at least partly, of an electrically conductive material such as carbon. However, they can also be formed at least partly from a poorly electrically conducting or nonconducting material. Such fibers **521** are preferably at least partly embedded in the rest of the material of the conducting substrate **51** and increase its mechanical strength. Such a conducting substrate **51** could thus have, e.g., a metal layer or graphite layer around a strandlike substrate support **52** and inclusions of additional carbon or metal fibers.

One or more lines preferably have a plurality of conducting particles **7**. By particle is meant small units of material, e.g., particles, granulate, fibers, fiber fragments, powder, grains or mixtures thereof, that are preferably smaller in one, two or three dimensions than 2 cm, better 1 cm, better 5 mm, better 2 mm, better 1 mm. Preferred are diameters of around 50 μm to around 3 mm, better 0.01-4 mm, and/or lengths of around 50 μm to around 20 cm (better 0.01-5 cm). Such conducting particles **7** are economical, corrosion-resistant and temperature-insensitive. A conducting particle **7** can form a conducting substrate **51**. It can also be provided that a plurality of conducting particles **7** a conducting substrate **51**, possibly making use of an adhesive compound **522**.

A certain fraction or basically all conducting particles **7** are formed from a preferably homogeneous, preferably electrically conductive material, preferably at least a fraction being carbon, steel, intrinsically conductive plastic, carbon black-filled Lycocell or other metals. Fiberlike particles are especially suitable, since when embedded in an adhesive compound **522** they enable a better current conductivity. Especially suitable are carbon nanotubes, graphite nanofibers or carbon filaments. This ensures a good electrical conductivity, mechanical robustness, and corrosion resistance. Carbon nanotubes (CNT) are tubular formations of carbon with a diameter of around 1-50 nm and a length of up to several millimeters. The electrical conductivity of the tubes is metallic, semiconductor, or at low temperatures superconducting. CNTs have a density of 1.3-1.4 g/cm^3 and a tensile strength of 45 billion Pascal. The current-carrying capacity is around 1000 times that of copper wires. The thermal conductivity at room temperature is 6000 W/m*K. Graphite nanofibers are (massive) fibers of carbon with a diameter less than 1 μm.

A certain fraction or basically all of the conducting particles **7** are at least partly embedded in an adhesive compound **522** (e.g., a lacquer, glue, or paste) and/or bonded to its surface. It can also be provided that they are entirely enclosed by the adhesive compound **522** (polyurethane based). Preferably the conductive particles form only at most 10% of the volume share of the resulting material, preferably at most 5%, or better 1%.

A certain fraction or basically all of the conducting particles **7** are preferably partly or basically entirely spaced apart from a surface being temperature controlled **10**. In particular, regions of conducting particles **7** that are not embedded or not bonded preferably protrude from an adhesive compound **522** on the side turned away from the user and/or they are arranged on this side. Such a material, which contains conducting particle **7** and adhesive compound **522**, can be, e.g., a dispersion, such as a paint material. Preferably, this material contains surfactants. It is preferably corrosion-resistant, tear-resistant, and economical in price.

Preferably every one or more lines **5**, **5'**, **5"**, conducting substrates **51**, conducting strands **55**, heating devices **44** and/or temperature-controlled objects **100** have at least one jacket **53**. The jacket **53** is at least partly arranged on the surface of a jacketed component and has one or more properties which the surface of the jacketed component does not have. By a jacket **53**, the jacketed component is preferably at least partly separated from its surroundings. A jacket **53** is also, e.g., a formation that directly or indirectly at least partly covers or encloses the jacketed component, but not necessarily the outermost part of the jacketed component. A jacket **53** can be, e.g., configured sheetlike as a layer, tubular as a sheath, or in the form of a netting. Such a jacket **53** can be at least partly electrically conductive and form, e.g., a conducting substrate **51**, an EMC screen, an antistatic coating and/or a signal transmission device. It can also be at least partly poorly electrically conductive or nonconductive and form, e.g., an insulation, a corrosion protection against aggressive media, a transfer protection and hot-spot protection, an adhesive connection device and/or a reinforcement of the mechanical strength of a line **5**.

A jacket **53** can be made partly or basically entirely from plastic, adhesive, insulating material or a conductive material like metal, e.g., copper of sliver. It can, for example, be extruded, galvanized, dipped and/or polymerized. For this, preferably at least a part of the surface of the line and/or the conducting substrate is coated, especially with a plastic and/or an adhesive, a lacquer and/or at least for a section with polyurethane, PVC, PTFE, PFA and/or polyester. Such lines are especially corrosion-resistant and can furthermore be glued together by means of the coating.

It may be advisable that at least one jacket **53** and/or at least one conducting substrate **51** have, at least at parts of their surface, a surface that is chemically inactive under usual environmental conditions, at least on its surface facing outward (in terms of a substrate support **52** or a jacketed component). Chemically inactive means inert, i.e., the so designated object is not altered, even under the action of corrosive substances, at least not in the case of such substances as sweat, carbonic acid or fruit acids. The material can also be chosen so that it either does not corrode or forms electrically conductive corrosion products. For this, a metal can be provided whose surface can be passivated and/or is oxidized and/or is chromated. Especially suitable for this are noble metals like gold or silver. It is provided here that at least one conductor is formed, at least at parts of its surface, to contain metal, preferably at least fractions of nickel, silver, copper, gold, and/or an alloy containing these elements, preferably essentially entirely made from one of the mentioned materials. This reduces the junction resistance at a contact surface between a heating and a contact conductor. It is advisable for the jacket **53** to be metal-containing, preferably at least a fraction being made from an alloy, from nickel with phosphorus fractions, from silver, copper and/or from gold, preferably from an alloy that is basically entirely formed from silver, copper, gold and/or nickel. But it can also be made partly or basically entirely from each of the materials described for conducting substrates **51** and/or for substrate supports **52**.

Preferably at least one line **5** has one or more conducting fields **5***a*. By the latter is meant an essentially sheetlike, at least partly electrically conductive structure. For example, it can have a foil, a textile or the like as conductive or nonconductive substrate support **52**. A conducting field **5***a*, in any case, has one or more conducting substrates **51**. Such conducting substrates **51** can either themselves form the essential component of the conducting field **5***a* (e.g., as nonwoven fabric made from electrically conductive fibers) or be arranged on or in a sheetlike substrate support **52** (e.g., as conducting strands sewn on or knitted into a textile support).

Preferably a plurality of conducting strands **55** and/or conducting fields **5***a* is provided, preferably in one or more contacting devices **46** and/or one or more resistance devices **45**. Preferably one or more conducting strands **55**/conducting fields **5***a* of a contacting device **46** are spatially and/or electrically connected to one or more conducting strands **55**/conducting fields **5***a* of a resistance device **45**.

At least one line **5** and/or one conducting field **5***a* has preferably one or more conducting strands **55** or is at least partly configured as such. The conducting strand **55** can be, e.g., a heating strand, a contact strand, an electrical fuse and/or a connection conductor. A conducting strand **55** is an at least partly electrically conductive strand, in which one or more filamentary, at least partly electrically conductive components extend, preferably basically along the lengthwise direction of the strand and/or arranged helically about it or in it. A conducting strand **55** can itself be made up from a plurality of conducting strands **55** or other, e.g., nonconductive partial strands.

By strand is meant here an elongated structure, whose lengthwise dimensions are far greater than the dimensions of its cross section. Preferably the two dimensions of the cross section have roughly the same dimensions. Preferably the structure is bending elastic. By filamentary is meant that the object so designated is formed from a short or long fiber or from a monofilament or multifilament thread. Preferably at least one strand has in at least one dimension a cross section dimension less than 1 mm, better 0.1 mm, better 10 μm.

Preferably one or more lines **5** and/or several conducting strands **55** have a plurality of partial strands **57**, preferably more than five, preferably more than 50, preferably more than 100, preferably more than 300. One, several or basically all partial strands **57** have a thickness of less than 1 mm, preferably less than 0.1 mm, preferably less than 10 μm. A partial strand **57** is a strand that together with other strands forms a higher-level strand. It can be advisable for a conducting strand **55** and/or a line **5** to have two or more different types of partial strands **57**. It can be provided that these have different materials and/or different dimensions from each other.

Preferably one, several or basically all partial strands **57** of a conducting strand **55** and/or a line **5** are formed at least in a fraction from copper or a copper alloy, preferably essentially from this. It can also be provided that one, several or basically all partial strands **57** of a conducting strand **55**, a substrate support **52** and/or a line **5** are made of plastic and have a jacketing with copper and/or a copper alloy. Preferably, fewer than 50% of the partial strands **57** are of copper, copper alloy, and/or another metal-containing material, preferably 1% to 40%, preferably 10% to 35%. Preferably a number of more than 50% of the partial strands **57** are provided with a plastic core, preferably between 60% to and 99%, preferably between 60% and 80%. These values have been found by several test series to be especially favorable in terms of costs and durability.

Preferably one or more supporting strands **58** are provided, which take up a large portion of the mechanical load on the conducting strand **55** and/or the line **5**. They are preferably made of a material that is stronger/tougher/less elastic than the material of the other strands, e.g., as here, basically from polyester or steel. Depending on the application, they are also preferably thicker and more numerous than the other strands. In this way, even thin strands can be effectively protected against bending and tensile stresses. The supporting strands **58** can be made for a fraction or basically entirely from an electrically conductive material and also from a poorly electrically conductive or nonconductive material.

Preferably one, several or basically all partial strands **57** are for a section or basically entirely electrically insulated from one, several or basically all other partial strands **57** of a strand. This can be done, e.g., by spacing them apart, e.g., by providing an air gap or by coating of one or more partial strands **57** or filling the strand interstices with an insulating material. By insulating material is meant any material whose specific electrical conductivity is at most one tenth of the specific electrical conductivity of at least one conducting substrate **51** of a conducting strand **55**.

Preferably at least one line **5**, at least one substrate support **52**, at least one conducting strand **55**, at least one partial strand **57** have at least for a section a round cross sectional shape. This enables a cost-effective manufacture. Alternatively or additionally, a nonround, especially a polygonal or star-shaped cross section will be considered for these or other structural parts. This allows for an enlargement of the surface. In this way, the electrical resistance of a coating is reduced as compared to a coating of the same thickness on a round cross section. A three-lobed cross section can further increase the abrasion resistance.

One or more conducting substrates **51** and/or one or more conducting strands **55** preferably have a spiral spatial arrangement, preferably by being twisted or stranded together and/or by helical arrangement about a strand, e.g., a substrate support **52**. This enables heating conductors with particular tensile strength.

A line **5** preferably has one or more supporting devices **8**, in order to carry additional components (e.g., the line **5**). One or more such components are fastened to such a supporting device **8** by sewing with or without auxiliary threads, gluing, lamination, knitting on, knitting in, weaving in, metallization, etc.

One or more supporting devices **8** are preferably essentially strandlike, netlike and/or sheetlike and formed at least partly from a textile, knitted fabrics weave, nonwoven fabric, flexible thermoplastics, air-permeable material and/or a foil (e.g., punched or nappy). One or more supporting devices **8** can also be formed partly or basically entirely at least by a portion of the temperature controlled object **100**, e.g., an interior furnishing object or at least a part of the temperature-controlled surface **10**, e.g., the cover **2**. Since the same requirements in terms of mechanical, chemical and electrical properties often hold for a supporting device **8** as for the substrate support **52**, it can be provided that it be formed partly or basically entirely from at least one material recommended here for substrate supports **52**. It can also be provided that a substrate support **52** itself forms a supporting device **8**.

Preferably at least one heating resistance is formed by impregnating a textile (e.g., a nonwoven fabric) in an immersion bath, by imprinting a cover, from leather or foil, or by lacquering a hard object. The coating material here is preferably a dispersion of a bonding, hardening support substrate and electrically conductive particles.

A heating device **44** can have at least two heating fields of different width (e.g., FIG. **2***e*)). A heating device **44** can also have at least two heating fields of different length (e.g., FIG. **2***e*), FIG. **2***f*)). Preferably the at least two heating fields are connected by at least one shared contacting device **46** (e.g., an electrode) with at least one connection line **461** to an electrical potential (e.g., a pole of a battery) (e.g., FIG. **2***e*), FIG. **2***f*)). Preferably at least two heating resistances (measuring at their electrodes) have an essentially identical electrical resistance, but as different electrical conductivity from each other (considering identically long segments along the direction of current flow through the heating resistance). Ways of achieving this effect could be, for example:

a. At least two coatings of different thickness of a supporting device **8** with the same conductive coating material. This can be done, e.g., when imprinting a supporting device **8** with conductive paste by a different dense arrangement of ink spots on the supporting device **8**. Especially suitable here is tampon printing, in order to imprint 3-dimensionally shaped supporting devices **8** (e.g., steering wheels **102**, door panels, dashboards **103** or housings).

b. At least two resistance zones, in which a different number of layers of a coating material is placed on a supporting device **8** (e.g., by several printing processes in succession).

c. Coating materials with differing kind of specific conductivity on two different zones of a supporting device **8** (e.g., by different concentrations of particles or by particles in the support substrate differing in size, shape or material, or by support substrates of different conductivity).

d. A different degree of cross-linking of the conductive particles **7** in different resistance zones. By cross-linking is meant here all electrical contact points and especially all mechanically firm connections, especially intimate material connections, especially chemical connections, especially joining together of molecules, especially those of identical components, such as carbon lattices. Such cross-linking can be achieved, e.g., by flow of current through a heating resistance, which is preferably at least twice as high as the normal operating current. If different regions of a heating resistance or different heating resistances are subjected to different current magnitudes, different numbers of connection points will be formed between the particles **7** (this effect is based, e.g., on the migration of ions in the material).

e. Different orientation of the conducting particles **7**. This can occur, e.g., by stretching of a heating resistance or certain zones thereof (e.g., by extruding of strand material or drawing of films).

LIST OF REFERENCE NUMBERS

2 cover
3 cushion
4 air conditioning device
5, **5'**, **5"** electric line
5*a* conducting field
7 conducting particle
8 support device
10 temperature-controlled surface
21 structural part
41 air conducting devices
42 humidity regulating device
43 temperature control device
44 heating device
45 resistance device
46 contacting device
47 circuit breaker
49 detector device
51 conducting substrate
52 substrate support
52*a* inner strand
53 jacket
55 conducting strand
57 partial strand
58 support strand
99 motor vehicle
100 temperature-controlled object
101 steering device
102 steering wheel
103 dashboard
105 door paneling
110 seat
461 connection line
521 fibers
522 adhesive compound

What is claimed is:

1. An electric line comprising:

at least one conducting substrate including at least two heating fields of a different width,

at least one shared contacting device including:

a coating material disposed on the conducting substrate that forms the at least two heating fields, and wherein the same coating material is disposed on the at least two heating fields, and

wherein the coating material is applied to the at least two heating fields in a sufficient amount so that each of the at least two heating fields have an identical electrical resistance, and

wherein the at least one shared contacting device connects the at least two heating fields to an electrical potential by one or more connection lines.

2. An electric line device according to claim **1**, wherein each of the at least two heating fields have a different amount of layers of the coating material.

3. An electric line according to claim **1**, wherein each of the at least two heating fields have a different thickness of the coating material.

4. An electric line according to claim **1**, wherein the at least two heating fields are rectangular in shape.

5. An electric line according to claim **2**, wherein each of the at least two heating fields have a different length, forming a heating field with a longest length and a heating field with a shortest length, and

wherein the heating field with the shortest length has the least amount of layers of the coating material and the heating field with the longest length has the largest amount of layers of the coating material.

6. An electric line according to claim **3**, wherein each of the at least two heating fields have a different length, forming a heating field with a longest length and a heating field with a shortest length, and

wherein the heating field with the shortest length has a smallest thickness of the coating material and a heating field with the longest length has a biggest thickness of the coating material.

7. An electric line according to claim **1**, wherein the at least one shared contacting device is an electrode.

8. An electric line according to claim **1**, wherein the electrical potential is a pole of a battery.

9. An electric line according to claim **1**, wherein the at least one shared contacting device forms a curve.

10. An electric line comprising:

at least one conducting substrate including at least two heating fields of a different width,

at least one shared contacting device, and

a coating material disposed on the at least one conducting substrate in each of the at least two heating fields of different widths;

wherein the at least one shared contacting device connects the at least two heating fields to an electrical potential by one or more connection lines; and

wherein at least one of the at least one conducting substrate includes one or more conductive particles, and an adjacent one of the at least one conducting substrate is made of one or more conductive particles so that a conductivity of the at least one of the at least one conducting substrate and the adjacent one of the at least one conducting substrate are different so that upon application of the electrical potential in the at least two heating fields, each of the at least two heating fields have an identical electrical resistance.

11. An electric line according to claim **10**, wherein the conducting substrate differs by concentrations of the conductive particles.

12. An electric line according to claim **10**, wherein the conducting substrate differs by size of the conductive particles.

13. An electric line according to claim **10**, wherein the conducting substrate differs by shape of the conductive particles.

14. An electric line according to claim **10**, wherein the conducting substrate differs by conductivity of the conductive particles.

15. An electric line according to claim **10**, wherein the conducting substrate differs by orientation of the conductive particles.

16. An electric line according to claim **15**, wherein at least one resistance zone of the at least two heating fields has a different orientation of the conductive particles.

17. An electric line comprising:

at least one substrate including at least two heating fields of a different width, and

a coating material disposed on the at least one substrate in each of the at least two heating fields of different widths;

wherein a plurality of conductive particles forms the coating material disposed on the at least one substrate,

wherein a degree of cross-linking of the plurality of conductive particles differs in each of the at least two heating fields so that a conductivity of each of the at least two heating fields is essentially identical.

18. An electric line according to claim **17**, wherein the electric line further comprises at least one shared contacting device.

19. An electric line according to claim **17**, wherein the one or more heating fields have a different length.

20. An electric line according to claim **15**, wherein each of the at least two heating fields have a different number of connection points between the plurality of conductive particles.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 8,456,272 B2
APPLICATION NO. : 13/181600
DATED : June 4, 2013
INVENTOR(S) : Rauh et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title Page 2, insert under item (56), col. 2, line 22,

-- NON-PATENT LITERATURE DOCUMENTS
1. Co-pending patent application serial no. 12/096,266, filed on 06/05/2008, published as 2008/0290080 (1063.015).
2. Co-pending patent application serial no. 13/204,152, filed on 08/05/2011, published as 2012/0018414 (1063.015C1).
3. Co-pending patent application serial no. 12/447,998, filed on 04/30/2009, published as 2010/0044075 (1063.021).
4. Co-pending patent application serial no. 12/738,345, filed an 03/31/2011, published as 2011/0290785 (1063.033).
5. Co-pending patent application serial no. 12/963,030, filed on 12/08/2010, published as 2011/0147357 (1063.038). --

Signed and Sealed this
Fifth Day of November, 2013

Teresa Stanek Rea
Deputy Director of the United States Patent and Trademark Office